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ABSTRACT

Presented is a course outline for the study of microorganisms, what they are, and how they solve the two basic problems of life - staying alive and reproducing. Much emphasis is placed on the physiological activities of bacteria. The course is designed for the average student in biology and could be used as a first course in biology. Experiments suggested are taken from three versions of the Biological Sciences Curriculum Study (BSCS) courses and the BSCS Laboratory Block, "Microbes, Their Growth, Nutrition and Interaction." The performance objectives are listed, the course outline presented and the entire curriculum suggested. A variety of laboratory activities are suggested at many levels of sophistication. The author suggests the course be used involving a variety of teaching strategies. (EB)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

MICROBIOLOGY

5314.17

SCIENCE

(Experimental)

SE 016 517

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

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MICROBIOLOGY

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SCIENCE

(Experimental)

Written by William C. Gunn
for the
DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida
1972

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MICROBIOLOGY

COURSE DESCRIPTION

This is a course about microorganisms -- what they are, and how they solve the two basic problems of life -- staying alive and reproducing. Much emphasis has been placed on the physiological activities of bacteria.

ENROLLMENT GUIDELINES

This course is designed for an average student in biology. Prior courses would be helpful, but are not prerequisite.

STATE ADOPTED TEXTBOOKS

1. Biological Sciences Curriculum Study. Biological Science, An Inquiry into Life. 2nd Edition. New York: Harcourt, Brace and World, 1968.

2. Biological Sciences Curriculum Study. Biological Sciences, Molecules to Man. 2nd Edition. Boston: Houghton Mifflin Company, 1968.

3. Biological Sciences Curriculum Study. BSCS Green Version High School Biology. 2nd Edition. Chicago: Rand McNally and Company, 1968.

4. Sussman, Alfred S. A Laboratory Block, Microbes, Their Growth, Nutrition and Interaction. Boston: D. C. Heath and Company, 1964.

RECOMMENDED TEXTBOOK

5. Sistrom, W. R. Microbial Life. New York: Holt, Rinehart and Winston, 1962.

PERFORMANCE OBJECTIVES

The student will:

1. Recognize the characteristics of the protists which are the basis for their classification.
2. Formulate a hypothesis based on observations and inferences drawn from microbial experiments.
3. Differentiate the roles of bacteria as producers or consumers.
4. Trace how matter (water, CO_2, N_2 and S) moves cyclically between the non-living and the living world.
5. Explain the functions of enzymes in aerobic and anaerobic systems.
6. Given the names of organic molecules as building blocks, identify the classes of compounds the cell can synthesize from these building blocks.
7. Compare aerobic and anaerobic respiration in bacteria.
8. Form a generalized equation for bacterial photosynthesis.
9. Explain the difference between asexual and sexual reproduction in microbes in terms of genetic advantages and disadvantages.
10. Design an experiment to demonstrate some microbial activity.
11. Given a growth curve of a microorganism, interpret each stage of the curve in terms of cellular activity.
12. Classify bacteria on the basis of their morphology.
13. Identify the structural components of a bacterial cell.
14. Compare transformation with transduction.

COURSE OUTLINE

I. The Nature and Extent of the Microbial World

A. The importance of being small

1. Surface area to volume ratio

2. Rapid metabolism and reproduction

B. Plants, animals and protists

1. Difficulties in classifying microorganisms

2. Creation of the kingdom protista

II. A Survey of the Protista

A. The higher protists

1. The fungi, algae and protozoa

2. Their activities in nature

B. The lower protista

1. Blue green algae, myxobacteria, spirochaetes, bacteria, rickettsia

2. Their activities in nature

C. The techniques of microbiology

1. Preparation of culture media

2. "Capturing" and culturing microorganisms from nature

3. Isolation for pure culture study

III. The Bacterial Cell

A. Morphology

B. Mechanisms of cell division

COURSE OUTLINE (Continued)

IV. Energy Metabolism

A. The need for energy

B. Sources of energy

1. Sunlight

2. Chemical oxidations

C. Fermentation

D. Respiration

E. Respiration with inorganic reductants

F. The influence of oxygen on the growth of bacteria

G. Bacterial photosynthesis

V. Bacterial Nutrition and the Ecology of Bacteria

A. Nutritional requirements

B. The relationship between the cell and its environment

C. The role of microbes in the economy of nature

1. The carbon and oxygen cycle

2. The nitrogen cycle

3. The sulfur cycle

VI. Growth and Protein Synthesis

A. The growth of a population of bacteria

B. The synthesis of protein by bacteria

VII. Genetic Systems of Protists

A. Sexual reproduction in higher protists

B. Sexual reproduction in bacteria

COURSE OUTLINE (Continued)

C. Transformation and transduction

D. Gene transfer

VIII. Bacteriophage and virus

A. Life history of lytic phages

B. Plant and animal viruses

C. Lysogeny

EXPERIMENTS

BSCS. Student Laboratory Guide, An Inquiry into Life. 2nd Edition.

1. Microbial Techniques (Inquiry 9-1, p. 63)
2. A disease of Bacteria (Inquiry 9-2, p. 69)
3. Distribution of Microorganisms (Inquiry 10-1)
4. Staining and Observing Bacterial Cells (Inquiry 10-2, p. 70)
5. Descendants of a Single Cell (Inquiry 11-1, p. 74)
6. War on Bacteria (Inquiry 11-2, p. 77)
7. The Environment of a Microorganism (Inquiry 11-3, p. 78)
8. Discriminating Microorganisms (Inquiry 11-4, p. 80)
9. Fungus Among Us (Inquiry 12-1, p. 83)
10. Green Algae, Simple or Complex (Inquiry 12-2, p. 89)

BSCS. Biological Science, Molecules to Man. Revised Edition.

11. Investigating Sources of Bacterial Growth (Investigation 4-6, p. 95)
12. Investigating the Sources of Microbes (Investigation 4-8, p. 97)
13. Investigating Some Properties of Life (Investigation 4-13, p. 102)
14. Investigating the Effects of Mutants in Bacteria (Investigation 10-9, p. 244)
15. Investigating the Behavior of a Slime Mold (Investigation S-18, p. 775)

BSCS. Green Version High School Biology. 2nd Edition.

16. Study of a Yeast Population (Investigation 2-2, p. 53)
17. A Garden of Microorganisms (Investigation 6-1, p. 189)
18. Microbial Techniques, Populations (Investigation 6-2, p. 194)

EXPERIMENTS (Continued)

19. Microbial Techniques, Microscopic Study of Bacteria (Investigation 6-3, p. 198)
20. Microorganisms in a School Environment (Investigation 7-1, p. 282)
21. Investigating an Infectious Disease (Investigation 7-2, p. 282)
22. Decomposing Action of Soil Microbes (Investigation 7-4, p. 246)

BSCS. Laboratory Block, Microbes, Their Growth, Nutrition and Interaction.

23. Two Samples of Pond Water (Investigation 1, p. 11)
24. A Short History of Pond Water (Investigation 2, p. 17)
25. Bacterial Enrichment from a Carrot Medium (Investigation 3, p. 18)
26. Microbial Enrichment in Milk (Investigation 4, p. 22)
27. Algae Enrichment Culture (Investigation 5, p. 27)
28. Protozoal Enrichment Culture (Investigation 6, p. 32)
29. Fungal and Some Bacterial Enrichment Cultures (p. 32)
30. Growth Curve of Yeast (Investigation 8, p. 40)
31. Colony Growth of Bacillus Mycoides (p. 61)
32. Colony Growth of R. nigricans (Investigation 10, p. 61)
33. Effect of Temperature on Fungal Growth (Investigation 11, p. 62)
34. isolation of Antisocial Microbes (p. 96)
35. Production of Antibiotics (Investigation 12, p. 105)
36. Effect of an Antibiotic on a Bacterium (p. 189)

DEMONSTRATIONS

1. Sterilization of Laboratory Glassware
2. Preparation and Sterilization of Culture Media
3. Preparation of Agar Slant Cultures
4. Aseptic Transfer Techniques
5. Plating
6. Staining
7. Colony Counting

PROJECTS

1. Isolate and do physiological studies of a marine phosphorescent bacterium.

2. Conduct a population study of bacteria in a fresh water lake in relationship to some environmental factor such as seasonal temperatures, pH or protozoans.

3. Irridiate bacteria to see if you can obtain mutants.

4. Attempt to induce mutations in bacteriophages.

5. Do an ecological study of canals by testing for the presence of coliform bacteria as an indication of pollution.

6. Usually in mixed bacterial flora from the soil, antibiosis is seen on an agar culture. Isolate the colonies which seem to produce antibiotics and plate with a number of known bacteria to see results.

7. Use paper chromatography to investigate the biochemistry of dormant sclerotia and active plasmodia of the slime mold Physarum.

8. Explore extracellular enzymatic digestion of a bacterium by dialysis.

REPORTS

Students can abstract Scientific American articles listed in the references. These can be presented as written reports or as seminar type presentations.

FIELD TRIPS

1. Dairy bacteriology laboratories

2. Sewage treatment plants

3. Municipal water works

4. Pathology lab in a local hospital

5. County Health Department

SPEAKERS

Consult the Visiting Scientist Program, Florida Academy of Sciences, see brochure, or a representative of any of the facilities listed under Field Trips.

SPECIAL PROBLEMS

1. The course outline is based on the book, Microbial Life, by W. R. Sistrom. It is an excellent little book on microbiology which emphasizes bacteriology.

2. A variety of laboratory activities are suggested at many levels of sophistication. It would be impossible to complete all the labs within a quinmester. The teacher should choose those labs which are best adapted to his students' ability levels, time schedules, and facilities. Order materials in advance so they will be available when needed.

3. This course as written does not mandate the curriculum. Hopefully it can be adapted to a variety of teaching strategies.

4. References are included in BSCS Blue, Green, and Yellow Versions. A few copies of each of these should be available in the resource center or classroom.

5. The Scientific American articles give in-depth descriptions of most of the recent research contained in the course text and outline.

6. There is always the danger of mutations occurring in bacteria in the laboratory. The teacher must emphasize the necessity for sterilization of all materials used and the proper disposal of cultures.

7. It will probably be necessary to demonstrate aseptic techniques, inoculating, and transferring procedures to students with no previous experience with microbes.

FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1. Antibiotics
   1-11356, 14', B/W

2. Bacteria
   1-30665, 28', C

3. Bacteria, Friend or Foe
   1-02363, 11', C

4. Bacteria, Laboratory Study
   1-11118, 15', C

5. Body Fights Bacteria
   1-12969, 15', B/W

6. Careers in Bacteriology
   1-10328, 15', C

7. Defense Against Invasion
   1-11297, 15', C

8. Epidemiology of Salmonellosis in Man and Animals
   1-13004, 15', C

9. Germ Theory of Disease
   1-30730, 28', C

10. Immunization
    1-02316, 11', B/W

11. Life in a Drop of Water
    1-02719, 10', C

12. Infectious Diseases and Man Made Defenses
    1-03409, 11', C

13. Microorganisms, Beneficial Activities
    1-11358, 15', B/W

14. Microorganisms, Harmful Activities
    1-11360, 15', B/W

15. Microorganisms that Cause Disease
    1-03413, 11', C

FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER (Continued)

16. Microscopic Wonders in Water
I-02677, 10', C

17. Nitrogen Cycle
I-11093, 14', B/W

18. Paramecium
I-02724, 10', B/W

19. Penicillin
I-30729, 28', B/W

20. Protozoa
I-02171, 11', B/W

21. Simplest Plants, Algae and Fungi
I-11120, 14', C

22. Staining
I-07247, 10', C

23. Virus
I-30533, 28', C

24. Wheat Rust
I-11102, 15', C

25. Wonderful World of Dr. Vishniac
I-11146, 20', C

SUGGESTED DISCUSSION QUESTIONS

1. Discuss the evidence that bacteria and protozoa come from a common ancestor.

2. Describe the morphology of a typical bacterial cell, giving the major function of each part.

3. Describe the three pathways leading from glucose to pyruvic acid in bacteria.

4. Cite examples of respiration in bacteria using inorganic substances.

SUGGESTED DISCUSSION QUESTIONS (Continued)

5. Describe bacterial photosynthesis, including the raw and finished products.

6. Develop a simple scheme of classification for the protists.

7. Discuss several roles of bacteria as consumers.

8. Give examples of enzyme specificity in bacterial respiration.

9. Describe asexual reproduction in three different protists.

10. Describe evidence of sexual reproduction in bacteria.

11. Compare, including specific examples, transduction with transformation.

12. Describe viral replication within a bacterial cell.

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Scientific American Articles:

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2. Alvarado, C. A. and Chawtt, L. J. Bruce. "Malaria". May, 1962.

3. Bonner, J. "The Social Amoebae". June, 1949.

4. Benner, J. T. "Volvex, A Colony of Cells". May, 1950.

5. Cairns, J. "The Bacterial Chromosome". January, 1966.

6. Echlin, Patrick. "The Blue Green Algae". June, 1966.

7. Gorini, L. "Antibiotics and the Genetic Code". April, 1966.

8. Hotchkiss, Rollin D. and Weiss, Ester. "Transduction in Bacteria". November, 1956.

9. Kellenberger, E. "The Genetic Control of the Shape of a Virus". December, 1966.

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Scientific American Articles:

10. Langer, W. L. "The Black Death". February, 1964.

11. Lwoff, Andre. "The Life Cycle of a Virus". March, 1954.

12. Morowitz, H. J. and Tourtellotte, M. E. "The Smallest Living Things". November, 1962.

13. Rose, A. "Yeasts". February, 1960.

14. Stent, Gunther S. "The Multiplication of Bacterial Viruses". May, 1953.

15. Wollman, Elie L. and Jacob, Francois. "Sexuality in Bacteria". July, 1956.

16. Zinner, N. D. "Transduction in Bacteria". November, 1959.

Books:

1. Brock, Thomas. Milestones in Microbiology. Englewood Cliffs, New Jersey: Prentice Hall, 1961.

2. DuBois, Rene. Pasteur and Modern Science. New York: Doubleday, 1960.

3. Frobisher, M. Fundamentals of Microbiology. Philadelphia: W. B. Saunders Company, 1962.

4. Gibbs, R. Botany, An Evolutionary Approach. New York: McGraw Hill, 1950.

5. Hylander, C. T. The World of Plant Life. New York: McMillan, 1956.

MASTERSHEET--MICROBIOLOGY

Course Outline	Textbooks	Experiments	Projects	References	Field Trips	Films	Objectives
I	#1. pp. 198-210 #2. pp. 41-42 #3. pp. 191-209 #5. pp. 1-5	1,3,7,11,13		12		6,11,13,14,16,24	1
II	#1. pp. 198-210 #2. pp. 41-42 #3. pp. 198-209 #5. pp. 5-15	8,9,10,12,15,16,17,27,28,29	1	1,2,3,4,5,11,13		4,9,18,20,21,23	2
III	#1. pp. 207-203 #2. pp. 39-41 #3. pp. 192-194 #5. pp. 17-32	4,19,20,34			3,4,5	2,3,15	2,12,13
IV	#1. pp. 203-204 #2. pp. 151-152 #3. pp. 413-418 #5. pp. 33-56	2,25,26,35,36	6,8		1	1,19	2,5,7,8,10
V	#1. pp. 688-692 #2. pp. 735-736 #3. pp. 243-245 #5. pp. 57-69	5,18,30,31,32,33	5	10	2	5,7,8,10,12,17	2,3,4,10
VI	#1. pp. 205-206 #2. pp. 256-257 #3. pp. 191-209 #4. pp. 70-89	5,18,30,31,32,33	2,7,8	7			2,6,10,11
VII	#1. pp. 206-210 #2. pp. 244-247 #3. pp. 579-584 #5. pp. 90-100	6,14	3,4	8,9,14,15,6,16		22	2,9,10,14